Chapter 8

Herpetofauna of Montane Areas of Tanzania. 4. Amphibians and Reptiles of Mahenge Mountains, with Comments on Biogeography, Diversity, and Conservation

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Abstract

The Mahenge Mountains are located in the Eastern Arc Mountains, part of a global biodiversity hotspot. Few amphibian and reptile surveys have been conducted in this area, with only one study of the submontane forest zone. This previous study revealed a characteristic endemic Eastern Arc amphibian and reptile forest fauna. New studies outlined here extend the sampling time considerably and the geographical coverage (including Mselezi Forest Reserve). These studies reveal a remarkable diversity of amphibians and reptiles increasing known faunal diversity considerably, including several putative new species that await further taxonomic verification. Biogeographical analyses using Bray-Curtis indices show Mahenge clusters with the geographically close Udzungwa Mountains and Southern Highlands (non–Eastern Arc highland fragment including Mt. Rungwe). This clustering of areas suggests an interesting biogeographical history and deserves special attention in the future. In light of the remarkable amphibian and reptile diversity, conservation of Mahenge habitats, in particular Sali Forest Reserve, is desperately required.

Introduction

The Mahenge Mountains form the southernmost part of the Eastern Arc Mountains (EAM), a recognized biodiversity hotspot (Myers et al., 2000). These mountains constitute several relatively poorly known forest fragments. To the west, the Mahenge Mountains are bordered by the Kilombero floodplain, separating them from the Udzungwa Mountain range. To the south the mountains form an almost continuous mountain block with the Mbarika Mountains, which are linked to the Livingstone Mountains and the Southern Highlands north of Lake Nyasa (Fig. 1).

The Mahenge Mountains are estimated to have lost 89% of their original forest cover (Newmark, 1998), although the rate of loss appears to have declined in the last few decades. However, most of the forest fragments that remain in the Mahenge Mountains are small and heavily encroached upon due to accessibility and proximity to humans (Mbilini & Kashaigili, 2005). The forests consist of a number of fragments with different degrees of disturbance and natural habitats remaining. However, the two southernmost forests, Sali and Muhulu Forest Reserves (FR), have remained relatively intact due to their isolation.

Knowledge of the distribution of species across the fragmented forests of Mahenge is very incomplete. Currently, assessments of the Mahenge Mountains indicate that the area has one endemic vertebrate species (Mariaux & Tilbury, 2006), 11 Eastern Arc near-endemic vertebrates, and five Eastern Arc near-endemic trees (Burgess et al., 2007). Because of the relatively low species diversity and endemism in the Mahenge Mountains, it is ranked low on the list of conservation priorities for the Eastern Arc (Critical Ecosystem Partnership Fund, 2005).

Historically, biological research in the Mahenge Mountains has been limited. Early exploration surveyed the herpetofauna and small mammals in the 1960s in Mahenge (Rees, 1964; with material examined and described by Poynton, 1977, 1991, 2003). Parts of the Mahenge Mountains were the focus of research by Frontier Tanzania, including surveys of amphibians and reptiles. Research focused on Mahenge Scarp Forest Reserve, Nawenge Forest Reserve, and Nambiga Forest Reserve (outlined in the reports of Frontier Tanzania, 2001–2004). However, these areas constitute mainly lowland habitats (Hinde et al., 2001), including miombo-type habitats, and not submontane or montane forest habitats. A botanical appraisal of catchment forest reserves (Lovett & Pócs, 1993) provided information on the flora of the region and each

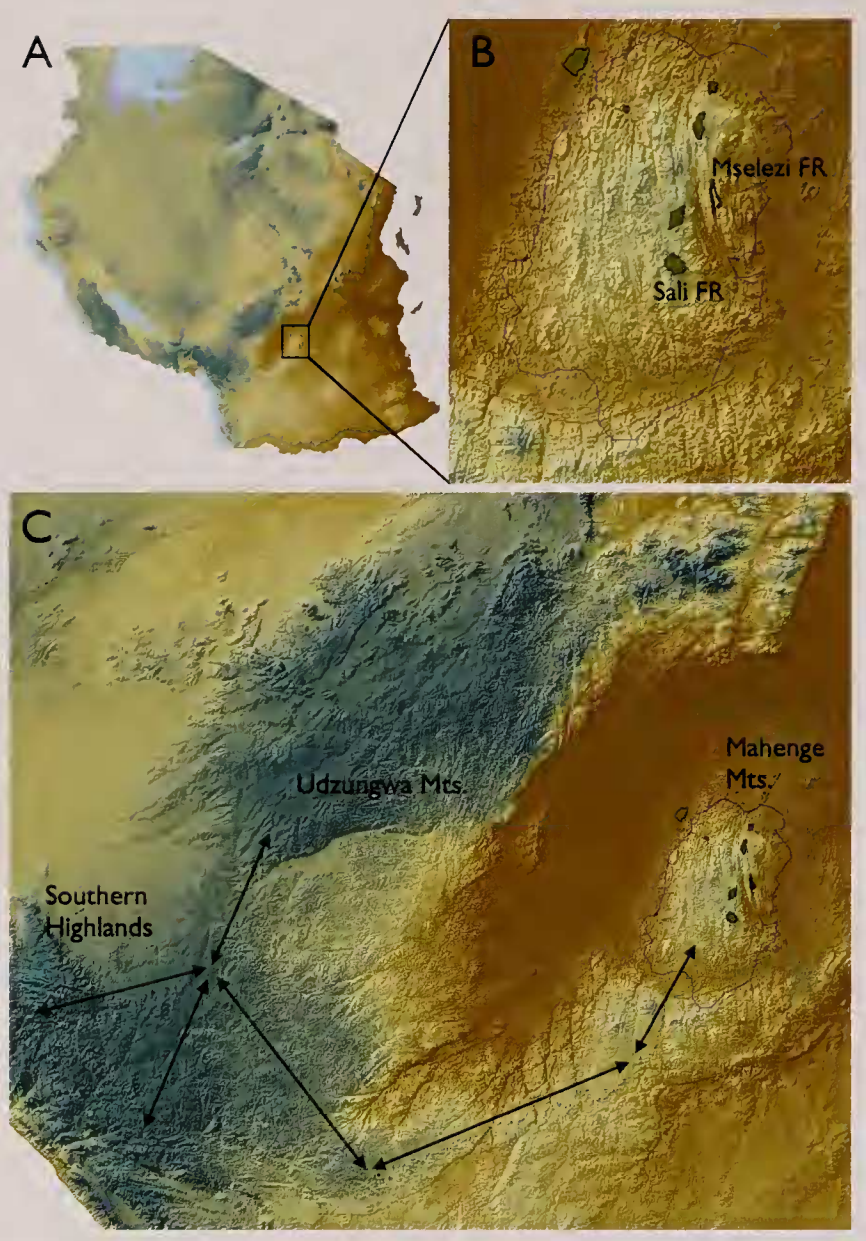

FIG. 1. Map of Tanzania showing (**A**) the position of the Mahenge Mountains within the Eastern Arc Mountains. (**B**) Position of surveyed forest fragments within the Mahenge Mountains landscape. (**C**) Possible faunal dispersal routes across Udzungwa, Southern Highlands, and Mahenge Mountains.

forest reserve. Several plant species with restricted distributions have been recorded (Lovett & Pócs, 1993). These include two endemic *Impatiens* spp. and the Eastern Arc endemic *Allanblackia stuhlmannii* (Lovett & Pócs, 1993). The presence of such species links the forest habitats to the biologically rich forests of the rest of the Eastern Arc Mountains.

Sali FR was the subject of one previous focused survey of the herpetofauna, updating the species inventory for amphibians and chameleons (Loader et al., 2004). The three-day survey provided the first glimpse of the affinities to other Eastern Arc submontane/montane forest herpetological assemblages. The presence of particular species strongly suggested Eastern Arc affinities, including *Scolecomorphus kirkii, Petropedetes yakusini, Leptopelis vermiculatus, Nectophrynoides tornieri,* and *Afrixalus uluguruensis*. Overall, given the lack of surveys in Mahenge, new field research continues to be required to make a proper assessment of the diversity of amphibians and reptiles in this Eastern Arc Mountain fragment.

This paper documents surveys recently conducted in Mahenge Mountains across two separate forest reserves. The surveys constitute the most intensive survey in this region and forest habitat, totaling 59 survey days. The work builds considerably on the three-day survey of Loader et al. (2004), which is the only known survey restricted to submontane forest habitats in the region.

Methodology

Study Area

The Mahenge Mountains are an Eastern Arc outlier of small, biologically poorly known forest patches. Covering 2,802.29 km^2, they are located at 8°37′–8°38′S and 36°42′–36°44′E, and rise from 460 to 1500 m above sea level (masl). To the west, the Mahenge Mountains are bordered by the Kilombero floodplain that separates them from the Udzungwa Mountain range and the Southern Highlands, and to the south, the Mahenge Mountains form a continuous series of ridges with the Mbarika Mountains, which are attached to the great mountain ranges north of Lake Nyasa. The forest fragments investigated are Sali and Mselezi Forest Reserves, both located in Ulanga District in Morogoro Region (Table 1; Fig. 1).

Field Survey Methods

Several techniques were used to collect amphibians and reptiles. Pitfall bucket lines were constructed at each field site for eight days to sample terrestrial herpetofauna, with two sites in Sali FR and one site in Mselezi FR. Three 50-m lines of drift fencing with 33 pitfall buckets were used for a total period of 792 trap-nights. Pitfalls were checked both in the morning and evening, with specimens collected from the buckets. Visual Encounter Surveys (VESs) of a total duration of 96 man-hours were used to sample quantitatively amphibians and reptiles through both quadrats and transects. VESs sample diurnal fossorial, arboreal, and water-associated species. Nocturnal acoustic monitoring techniques were used to detect the frog species. Furthermore, opportunistic sampling was made of all taxa throughout the survey. Material collected is listed in Appendix 1 by K. M. Howell collector numbers. The surveys were conducted between 12 Oct and 29 Nov 2005 in Sali FR and 25 Nov and 9 Dec 2005 in Mselezi FR. The taxonomy largely follows that of Frost et al. (2006). Tables 2 and 3 give the list of species for the two forest reserves surveyed.

The species collected were identified on the grounds of morphological, molecular, and bioacoustic analysis and through comparison with material held in the herpetological collections of the University of Dar es Salaam, Tanzania; the Natural Sciences Museum of Trento, Italy; and the Natural History Museum, London, United Kingdom, and are deposited in the Natural Sciences Museum of Trento. Molecular analyses were carried out at the Institute of Biogeography of the University of Basel, Switzerland. Analysis of similarity was performed with the software PAST—Palaeontological Statistics. A dendrogram was constructed based on a matrix of endemic and near-endemic Eastern Arc Mountain amphibian and reptile species by site, using the Bray–Curtis (Sørensen) similarity index.

Results

Species Diversity and Endemism

Tables 1 and 2 list the species recorded for the Mahenge Mountains across the two fragments surveyed in this study,

TABLE 1. History and geography of two Forest Reserves in the Mahenge Mountains. Information from Lovett and Pócs (1993) with updates from observations during the Frontier-Tanzania survey of Forest Reserves in the Mahenge Mountains (Frontier-Tanzania, 2004–2005).

	Sali FR	Mselezi FR
Year of establishment	1954	1954
Coordinates	8°54′–8°57′S, 36°37′–36°41′E	8°46′S, 36°43′E
Size (ha)	1890	2245
Altitude (masl)	1050–1500	500–900
Rainfall (mm/year)	1700	1500
Vegetation type	Primary submontane and montane forest; dry grassland, wetlands, rocky outcrops	Riverine lowland forest along the stream in the valley bottom; semi-evergreen drier lowland forest

and Figure 2 illustrates some of these taxa. The Mahenge Mountain herpetofauna, based on previous works (Hinde et al., 2001; Loader et al., 2004) and on the results presented here, comprises at least 41 species of amphibians in 13 families and 25 species of reptiles in eight families. The present study recorded seven amphibian taxa and one reptile taxon that are sufficiently distinct from the other known taxa that they may be considered new species based on the available data. Furthermore, the taxonomic status of all the species collected during the surveys has been assessed in the context of more extensive work on the genera, involving molecular, osteological, bioacoustic, and morphological analysis conducted from 2005 to date (S. Loader, unpubl. data; M. Menegon, unpubl. data; J. Poynton, unpubl. data). Specific determination is still in doubt for several taxa and will require further taxonomic work over the coming years, but all new putative species have minimally shown distinct genetic divergence (>3% difference using mitochondrial markers). For several putative species there is often supporting evidence for distinctiveness based on either vocalization and morphology or both. A similar case is shown in the Nguru Mountains (Menegon et al., 2008), and new species continue to be described from this area (e.g., Blackburn, 2008; Poynton et al. 2008; Loader et al., 2010).

Faunal composition includes typical elements of the Tanzanian lowlands, due to the close proximity to the Kilombero River valley (e.g., *Hyperolius tuberilinguis*, *Pyxyicephalus edulis*, *Phrynomantis bifasciatus*), and a majority of forest and highlands elements showing a strong link with the other forested areas in the Eastern Arc Mountains (e.g., species belonging to the genera *Callulina, Hoplophryne, Petropedetes, Probreviceps,* and *Nectophrynoides*). These EAM endemic or near-endemic amphibian genera are all represented by putative new species, highlighting the taxonomic distinctiveness of the Mahenge highland herpetofauna and further stressing the need for continued taxonomic assessment.

The forest-associated reptile assemblage is also distinctive, as exhibited in amphibians. A few putative new species are likely endemic to the Mahenge Mountains. A single female of the forest chameleon genus *Kinyongia* was collected, and it appears to be a distinctive species, closely related to the *K. oxyrhina* (Krystal Tolley, pers. comm.). *Kinyongia oxyrhina* is a species widely distributed across several of the Eastern Arc Mountain blocks, including Udzungwa, Uluguru, Nguu, Nguru, and Rubeho (Krystal Tolley, pers. comm.; Menegon, unpubl. data). The forest gecko *Cnemaspis* sp. is another putative endemic species new to science (Bauer & Menegon, in prep.). The Mahenge endemic dwarf chameleon *Rhampholeon beraduccii* collected and described from the previous survey in Sali FR already suggested the distinctiveness of the Mahenge reptile fauna. *Rhampholeon beraduccii* was again collected in the surveys outlined here. Other enigmatic findings are shown by the collection of two snake species. One specimen is tentatively identified as *Xyeledontophis* cf. *uluguruensis*, a poorly known species described from the Uluguru Mountains (Broadley and Wallach, 2002) and recently recorded in the Nguru Mountains (Menegon et al., 2008). Another interesting record is the burrowing asp *Atractaspis aterrima*, a Guineo-Congolian species, known also from a few localities within the Eastern Arc (Spawls et al., 2004; Menegon et al., 2008). Like amphibians, the occurrence of coastal/lowland elements is due to the close proximity of the Kilombero Valley, which contains lowland species and links to coastal areas along the Kilombero river valley (e.g., *Rieppeleon brevicaudatus*, *Dendroaspis angusticeps*, *Naja melanoleuca*).

Zoogeographical Patterns

Bray–Curtis Similarity Index values were computed for each Eastern Arc mountain fragment using non-transformed amphibian and reptile species occurrence data, based on Burgess et al. (2007), updated by recent publications (Blackburn, 2009), and unpublished data by the authors (Fig. 3). The pattern obtained shows an interesting clustering of sites reflecting similarities in species assemblages, which in general can be correlated to geographic proximity. The Taita Hills are separated from all the other sites, probably because of the paucity of Eastern Arc endemic and near-endemic species. The northernmost Tanzanian sites (North and South Pare Mountains) cluster together and are distinct from all other EAM blocks. The Pare and Taita differences reflect the distinctiveness of these assemblages (e.g., Müller et al., 2005; Loader et al. 2009, 2010). These results contrast with comparisons of amphibians given in Loader et al. (this volume) that identified closer links between West Usambara and South Pare to the exclusion of the North Pare Mountains. Clearly the biogeographical history of these areas remains uncertain and requires further detailed analyses using appropriate methodologies (e.g., historical biogeographical approaches).

Three other clusters are identified in the dendrograms constructed using the Bray–Curtis Similarity Index: (1) a cluster that includes the north-central Eastern Arc fragments (East and West Usambara, Nguru, and Uluguru); interestingly, the East and West Usambara do not form a single grouping; (2) the Central Eastern Arc region (Malundwe, Nguu, Rubeho, and Ukaguru), areas with relatively low species diversity but poorly surveyed; and (3) a southern Eastern Arc cluster, (Udzungwa, Mahenge, and Rungwe [Southern Highlands], which is a non–Eastern Arc Mountain fragment). We note the close relationship shared between Udzungwa and Rungwe, to the exclusion of Mahenge.

TABLE 2. List of the amphibians of Mahenge Mountains.

Taxon	Sali FR	Mselezi FR	Data source (if not present study)
Arthroleptidae			
Arthroleptis lonnbergi	X	X	
Arthroleptis sp. 1	X	X	
Arthroleptis cf. *reichei*	X	X	
Arthroleptis xenodactyloides	X	X	
Leptopelis flavomaculatus	X		
Leptopelis uluguruensis	X		
Leptopelis vermiculatus	X		
Bufonidae			
Amietophrynus gutturalis			Loader et al., 2004
Amietophrynus maculatus			Loader et al., 2004
Nectophrynoides cf. *tornieri*	X		
Nectophrynoides sp. 1	X		
Nectophrynoides sp. 2	X		
Mertensophryne loveridgei		X	
Hemisotidae			
Hemisus marmoratus			Loader et al., 2004
Hyperolidae			
Afrixalus cf. *uluguruensis*	X		
Afrixalus fornasinii	X	X	
Afrixalus sp. 1	X		
Afrixalus sp. (cf. brachycnemis)			Loader et al., 2004
Hyperolius puncticulatus	X		
Hyperolius mitchelli			Loader et al., 2004
Hyperolius tuberilinguis			Loader et al., 2004
Hyperolius nasutus			Loader et al., 2004
Hyperolius sp. 1	X		
Kassina senegalensis			Loader et al., 2004
Microhylidae			
Hoplophryne sp.	X		
Phrynomantis bifasciatus			Loader et al., 2004
Brevicipitidae			
Callulina sp.	X		
Probreviceps cf. *rungwensis*	X		
Breviceps mossambicus			Loader et al., 2004
Spelaeophryne metheneri	X	X	
Petropedetidae			
Petropedetes sp.	X	X	
Phrynobatrachidae			
Phrynobatrachus acridoides		X	
Phrynobatrachus natalensis	X	X	
Phrynobatrachus uzungwensis	X		
Ptychadenidae			
Ptychadena anchietae		X	
Pyxicephalidae			
Amietia angolensis	X		
Pyxicephalus edulis			Loader et al., 2004
Pipidae			
Xenopus muelleri			Loader et al., 2004
Rhacophoridae			
Chiromantis xerampelina			Loader et al., 2004
Scolecomorphidae			
Scolecomorphus cf. *kirkii*	X		Loader et al., 2004

Discussion

Loader et al. (2004) outlined the differentiation of the highland herpetofauna of the Mahenge Mountains from the lowland area of the Kilombero Valley. The assessment, based on amphibians, showed high turnover patterns across this transect, with the presence of key species only in the montane zone. These key species were associated with other highland areas of the Eastern Arc. The study by Loader et al. (2004) supported what was well understood by geologists and some biologists previously (Lovett & Pócs, 1993); these Eastern Arc highland regions have a shared biogeographic history, as implied by the species they share. However, based on the rather limited sampling and taxonomic understanding, no endemics

TABLE 3. List of the reptiles of Mahenge Mountains.

Taxon	Sali FR	Mselezi FR	Data source (if not present study)
Gekkonidae			
Cnemaspis sp.	X	X	Loader et al., 2004[1]
Chamaeleonidae			
Chamaeleo dilepis	X		
Trioceros melleri	X		
Kinyongia cf. *oxyrhina*	X		
Rhampholeon beraduccii	X		Loader et al., 2004[1]
Rieppeleon brevicaudatus	X	X	Loader et al., 2004
Scincidae			
Melanospes cf. *loveridgei*	X	X	
Trachylepis striata	X	X	
Typhlopidae			
Rhinotyphlops nucruso	X		Loader et al., 2004
Colubridae			
Crotaphopeltis tornieri	X		
Crotaphopeltis hotamboeia	X		
Dasypeltis medici		X	
Lycodonomorphus whitey	X		
Philothamnus hoplogaster	X		
Philothamnus angolensis	X		
Philothamnus semivariegatus		X	
Psammophis orientalis	X		
Natriciteres sylvatica	X		
Thelotornis mossambicanus	X	X	
Xyeledontophis cf. *uluguruensis*	X		
Lamprophiidae			
Lamphophis cf. *fuliginosus*	X		
Atractaspis aterrima	X		
Elapidae			
Dendroaspis angusticeps		X	
Naja melanoleuca	X	X	
Viperidae			
Causus defilippii	X		

[1] Data source shows different taxonomic identity.

were identified, but rather, species with seemingly larger distributions across southern Eastern Arc areas (e.g., *Scolecomorphus kirkii*) and in some cases potentially northern areas (e.g., *Nectophrynoides tornieri*). Closer scrutiny of the region was encouraged despite Mahenge's relatively low diversity. Mahenge's apparent close relationship to other hyperdiverse Eastern Arc areas suggested it might also be diverse, but lack of research had precluded a proper assessment.

In this study, we outlined new discoveries revealing a remarkable diversity of amphibians and reptiles of the Mahenge Mountains. Numerous putative new species have been identified but await further taxonomic work. These results improve substantially our understanding of the Mahenge Mountain herpetofauna. Surveys across a wider geographical area in Mahenge have identified putative new endemic species belonging to characteristic endemic Eastern Arc genera. The only previous survey conducted in this area (Loader et al., 2004), above 850 m in Sali FR, documented only seven montane Eastern Arc endemics or near-endemic species: *Scolecomorphus kirkii, Nectophrynoides tornieri, Speleaeophryne methneri, Petropedetes yakusini, Leptopelis vermiculatus, Afrixalus uluguruensis,* and *Hyperolius puncticulatus.* This study increased the total numbers substantially to 41 species, with radiations of putative endemic species belonging to genera previously recorded (e.g., *Nectophrynoides,* three species; *Leptopelis,* two species; *Afrixalus,* two species; *Arthroleptis,* two species). In addition, genera previously not recorded for this area include *Callulina, Hoplophryne,* and *Probreviceps.* Overall the increase in species diversity is remarkable and requires that remaining forest reserves in these regions to be assessed to understand how widely distributed these species are.

The documented diversity further exemplifies the hyperdiverse Eastern Arc amphibian fauna. Recent surveys, including those documented in this volume (Lawson & Moyer, 2008; Menegon et al., 2008; Loader et al., 2010), have started to establish that, beyond the well-surveyed forests (Uluguru, Udzungwa, and Usambara), areas previously considered less diverse often contain highly diverse assemblages after more extensive surveys are conducted. Surveys across all the fragmented forest areas of the Eastern Arc Mountains are required before anything can be presumed about species diversity.

The reptile fauna, even more poorly understood, is also a comparatively diverse assemblage in Mahenge. Prior to this study, only seven taxa were recorded; our surveys raised this total to 24 species, including one recently described endemic species (*Rhampholeon beraduccii*; Mariaux & Tilbury, 2006). Several reptiles are recorded as being putative new species, which await taxonomic verification (*Kinyongia* cf. *oxyrhina, Melanoseps* cf. *loveridgei, Crotaphopeltis* cf. *tornieri, Xyele-*

FIG. 2. Left column, descending: *Probreviceps* cf. *rungwensis*, *Callulina* sp., *Nectophrynoides* sp.; right column, descending: *Kinyongia* cf. *oxyrhina*, *Rhampholeon beraduccii*, *Cnemaspis* sp.

dontophis sp., and *Cnemaspis* sp.). The surveys also include the first records in this mountain fragment of the following genera: *Atractaspis*, *Kinyongia, Melanoseps, Crotaphopeltis,* and *Xyeledontophis*. This addition to the number of known reptile species in the area suggests that the region is both diverse with species characteristic of the Eastern Arc and contains numerous endemic species.

The presence of several Eastern Arc endemic or near-endemic genera and species suggests a strong link between the Mahenge Mountains and other EAM forested areas. Mahenge Mountains are geographically adjacent to the Udzungwa Mountains, and this proximity is also reflected in the close biogeographical relationships (see Fig. 3). Between these two areas is the deep and wide Kilombero Valley, which currently acts as a barrier to species dispersal. Evidence of this potential barrier has been provisionally outlined in the genetic differences exhibited by populations on either side of the Kilombero Valley. For example, populations of *Kinyongia oxyrhina* in Mahenge and Udzungwa show sufficient genetic differentiation to suggest long-term separation (Krystal Tolley, pers. comm.).

To the south, where the Mahenge Mountains are joined to the Southern Highlands by the Mbarika Mountains, dispersal might have also occurred across this southwestern corridor.

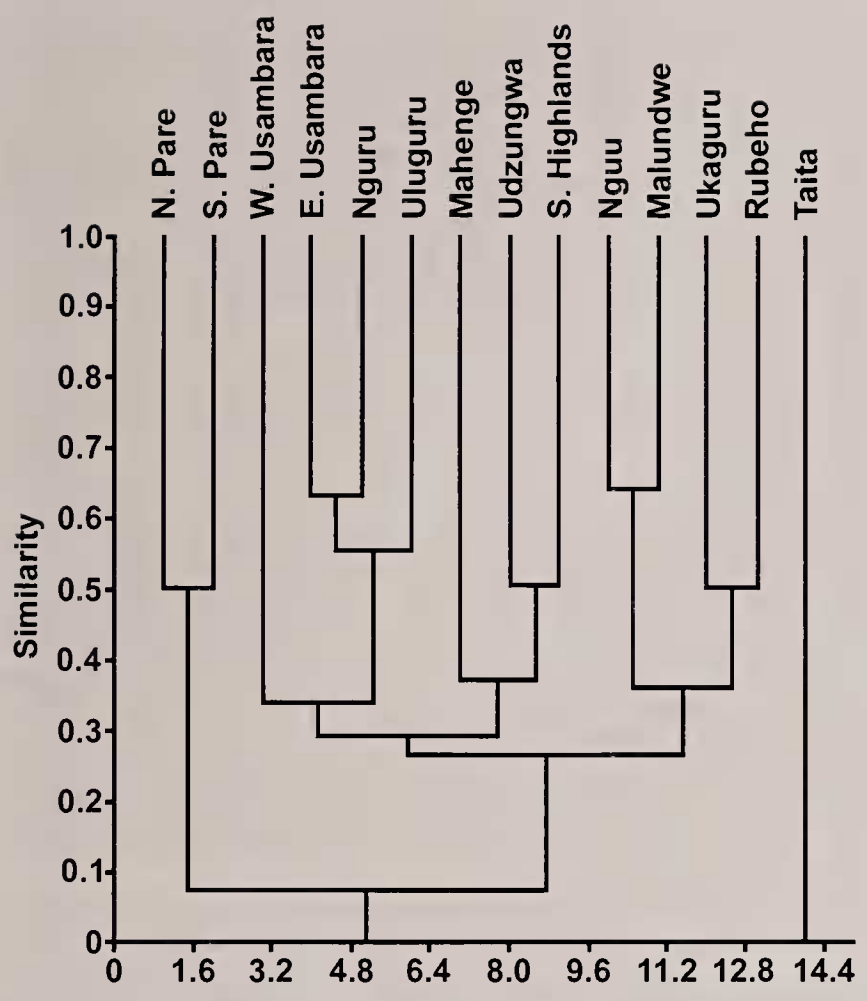

FIG. 3. Dendrogram based on a matrix of endemic or near-endemic Eastern Arc Mountain amphibian and reptiles species (n = 132) by site, using the Bray–Curtis (Sørensen) similarity index.

This is suggested by the clustering of the Southern Highland site, Rungwe, with Mahenge and Udzungwa. No previous studies exist that suggest the likelihood of this corridor as a potential route for amphibian and reptile species dispersal, but our evidence supports a close faunal similarity between the Mahenge Mountains, Southern Highlands, and Udzungwa Mountains. Interestingly, Rungwe groups with Udzungwa, and this might suggest barriers to dispersal are sufficiently weak between Udzungwa and the Southern Highlands to generate similarity between these faunas. More significant barriers to dispersal are assumed for both the Kilombero Valley (Mahenge-Udzungwa) and the Mbarika Mountains (Southern Highlands–Mahenge) as evidenced by Mahenge's more distinct assemblage in similarity measures. Further testing of these barriers would contribute to our understanding of the biogeographic history of this region of Tanzania. There is some evidence from phylogenetic studies, but this appears to show contrasting patterns. For example Mariaux and Tilbury's (2006) recent study of dwarf chameleons of the genus *Rhampholeon* showed that the nearest relative of *Rhampholeon beraduccii* is *Rhampholeon nchisiensis* of the Southern Highlands. Similarly, populations of *Probreviceps rungwensis* in Mahenge and the Southern Highlands cluster might potentially indicate that this pattern is a general trend. Whether Mahenge, Udzungwa, and Southern Highland faunal similarities can be explained by either dispersal, vicariance, or both patterns will require more comprehensive phylogenetic evidence.

The discovery of a highly diverse forest amphibian and reptile assemblage in a forest fragment of the Eastern Arc Mountains is not unremarkable. Focused survey effort has repeatedly revealed diverse assemblages in the Eastern Arc (e.g., Barbour & Loveridge, 1928; Menegon et al., 2008). Despite the small size of habitats, and often the level of disturbance, these small, ancient forest remnants harbor unique faunal communities (Lovett, 1993). Recent evidence has also suggested that many lineages have long evolutionary histories, presumably due to isolation and long-term persistence of habitats. This finding has further elevated the conservation value of the Eastern Arc Mountains (Burgess et al., 2007). Mahenge can be added as another example of a location showing high amphibian diversity and of high conservation importance.

Comparisons across the Eastern Arc suggest the total forest area is relatively small in Mahenge (see Burgess et al., 2007). Despite the small size of the natural vegetation remnants in Mahenge, species diversity is relatively high. In particular Sali FR, with its broad altitudinal coverage across the montane forest elements, has particularly diverse elements, including several possibly endemic species. The typical montane endemic element associated with the Eastern Arc is mainly restricted to Sali forests above 900 m, including species in the genera *Crotaphopeltis, Hoplophryne, Callulina, Nectophrynoides, Probreviceps, Scolecomorphus,* and *Xyeledontophis,* but absent from Mselezi forests. A taxonomic assessment of the species collected here is required to confirm their taxonomic status, together with focused conservation attention on Sali FR. Assessment of the remaining forest fragments in the Mahenge Mountains might reveal other areas that are equally diverse, and this remains a priority for future work in this area (particularly submontane and montane elements). If current species estimates are correct, Sali FR could rank among the most important forest reserve sites for the conservation of the forest herpetofauna in Eastern Africa. However, further voucher-based research is needed to test this hypothesis.

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Appendix 1

List of Material Collected with K. M. Howell (KMH) Collector Numbers

Amphibians

Arthroleptidae: *Arthroleptis* sp. 1—KMH 26255, 26238–40, 26265, 26267, 26268, 26463, 26636, 26655, 26656, 26983, 26985, 26987; *Arthroleptis lonnbergi*—KMH 26908; *Arthroleptis* cf. *reichei*—KMH 26632, 26633; *Arthroleptis xenodactyloides*—KMH 26253, 26423, 26460, 26642, 26657–60, 26982, 26984, 26988, 26989, 26995; *Leptopelis flavomaculatus*—KMH 26645; *Leptopelis uluguruensis*—KMH 26251, 26258, 26259; *Leptopelis vermiculatus*—KMH 26635, 26964, 26965; **Bufonidae:** *Nectophrynoides* cf. *tornieri*—KMH 26254, 26261, 26262, 26467, 26648, 26652, 26986; *Nectophrynoides* sp. 1—KMH 26252, 26259, 26260, 26263, 26264, 26649, 26650, 26912; *Nectophrynoides* sp. 2—KMH 26637–39, 26641, 26643, 26644, 26988, 26999; *Mertensophryne loveridgei*—KMH 26653; **Hyperoliidae:** *Afrixalus* cf. *uluguruensis*—KMH 26269, 26646, 26950, 26957, 26966, 26992, 26993; *Afrixalus fornasinii*—KMH 26462, 26634, 26952; *Afrixalus* sp. 1—KMH 26958, 26962, 26970, 26971, 26974; *Afrixalus* sp. 2—KMH 26651, 26968, 26980; *Hyperolius* cf. *puncticulatus*—KMH 26956, 26961; *Hyperolius* sp. 1—KMH 26955, 26959, 26960, 26967, 26972, 26976, 26977, 26979, 26996; *Hyperolius* sp. 2—KMH 26951, 26954, 26973, 26977, 26978; **Brevicipitidae:** *Callulina* sp.—KMH 26266, 26911, 26963, 26975; *Probreviceps* sp.—KMH 26256, 26640, 26969, 26991; *Spaleophryne methneri*—KMH 26461, 26990; **Microhylidae:** *Hoplophryne* sp.—KMH 26981; **Petropedetidae:** *Petropedetes* sp.—KMH 26242–50, 26419, 26420, 26907; **Phrynobatrachidae:** *Phrynobatrachus natalensis*—KMH 26422, 26459, 26654; *Phrynobatrachus acridoides*—KMH 26421, 26458; *Phrynobatrachus uzungwensis*—KMH 26241, 26953, 26994.

Additional specimen records in Loader et al., 2004.

Reptiles

Gekkonidae: *Cnemaspis* sp.—KMH 23945, 23946, 26756, 26757, 26762, 26767, 26768, 26772; **Scincidae:** *Melanoseps loveridgei*—KMH 23948, 26765, 26771, 26774; Trachylepis striata—KMH 26769; **Chamaeleonidae:** *Rhampholeon beraduccii*—KMH 26752, 26754, 26758, 26759, 26775; *Rieppeleon brevicaudatus*—KMH 23947, 26753, 26760; **Colubridae:** *Crotaphopeltis tornieri*—KMH 26781, 26763; *Crotaphopeltis hotamboeia*—KMH 26782, 26784; *Dasypeltis medici*—KMH 26780; *Lycodonomorphus whytei*—KMH 26773; *Natriciteres sylvatica*—KMH 26418, 26783; *Philothamnus semivariegatus*—KMH 23949; *Philothamnus* cf. *angolensis*—KMH 26417, 26779; *Philothamnus hoplogaster*—KMH 26416; *Psammophis orientalis*—KMH 26785; *Thelotornis mossambicanus*—KMH 26778; *Xyeledontophis* cf. *uluguruensis*—KMH 26755; **Lamprophiidae:** *Atractaspis aterrima*—KMH 26764; *Lamprophis* cf. *fuliginosus*—KMH 26766; **Viperidae:** *Causus defilippii*—KMH 26776, 26777.

Additional specimen records in Loader et al., 2004.